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DEVELOPMENT OF FLY ASH BASED NEW BIO-COMPOSITES MATERIAL AS WOOD SUBSTITUTE

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ABSTRACT

Fly ash is produce from the thermal power plant from the coal combustion as a problematic solid waste all over the world. India has some of the largest reserves of coal in world. The fly ash is collected from the renusagar power plant in Anpara U.P. India and Human Hair is collected from the local shop of shailoon. The composite plates are developed by using CY-230 resin. Human hair must have high strength. The specimen preparation and testing was carried out as per ASTM standards and mechanical properties like tensile, compressive and flexural stress of bio composite were evaluated. The experiments are carried out with the aid of Design Experts (Design of Experiment) software. The developed composites specimens are tested for tensile, flexural strength sand the result are validated with Anova-One way approach. Finally the properties of developed composite are compared with the corresponding properties of wood and conventional wood substitute.

KEYWORDS: Ash, Human Hair, Bio Composite & Mechanical Properties

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Original Article

INTRODUCTION

Bio composite material are a material composed of two or more different properties dissimilar material which exist in a different phases. Composite material are constituted of two phase; the matrix, which continuous and surrounds the other phase, often called as reinforcing phase. Bio composite material having good strength, low-cost, high toughness, bio-degrability composite was successfully used for many decades for all engineering application. Composite was most commonly used in the manufacture of composite materials. Epoxy resin is widely used as matrix in many fibre reinforced composite. The mechanical behaviour basically depends on the fibre and fly ash strength and modulus. Epoxy resin has high chemical/ erosion resistance properties, low shrinkage on curing. The capability to be processed under various condition and high level of cross linking epoxy resin network to brittle material. Human hair is a material considered useless in most societies and therefore is found in the municipal waste streams in almost all cities and towns of the world.

Even before, some efforts are made to utilize such wastes in development of composite. **P. Gopinath& P. Suresh (2014)** in a work tested the mechanical behaviour of fly ash filled, woven banana fiber reinforced hybrid composites as wood substitute. The experiments are carried out with the aid of Design Experts (Design of Expert)

software. And the results are valid with Anova-one way approach. The develop composite was superior than the wood.

SevgiHoyur (2012): Carried a word on production of banana and glass fiber reinforced bio-composite profile and tested its bending strength and used polyester resign as matrix. In order to gain higher strength on the outer surface, the glass fiber and polyester binding were used in hand lay-up process. The tested result showed that the highest and lowest bending strength for a single layer specimen were lower than double layer specimen.

Yetgin et al. (13): Studied the compression and tensile tests for five different adobe mixtures. The important part of this study consisted of uniaxial compressive tests done with natural fiber mixtures. Thus, the results obtained from mechanical tests were presented in the form of stress–strain graphs. In addition, mechanical properties were related to the water content for workability, unit weight and fiber contents and discussions were given. The results show that as fiber content increases, compressive and tensile strengths decrease, and shrinkage rates decrease.

Gassan and Bledzki [11]: Used the coupling methods to improve the properties of composites. Composites have high level of moisture absorption, poor wet ability, and insufficient adhesion between untreated fibers and the polymer matrix leads to debonding with age. To improve the properties of the composites, the natural reinforcing fibers can be modified coupling methods. The coupling agents have chemical groups which can react with fiber or polymer and thus improve the interfacial adhesion.

EXPERIMENT DETAIL

Materials

Human hair fiber collected from the local saloon. The fly ash are the wastes from the thermal power plant, are collected from the Renusagar Power Plant, Renukoot, Sonbhadra, Uttar Pradesh, india. The CY-230 resin of density 1.176 gm/cm^3, and catalyst are collected from the Singhal Chemical Corporation, Meerut, U.P., India

Preparation of Mould

The mould is prepared for the tensile, compressive and flexural test of iron sheet on the basis of ASTM. The mould are welded by the arc welding. The bottom of the mould is made fram a thick wood. The inner side of the mould is coated with a releasing wax. The top of the mould is cover with a plywood sheet for applying load.

Fabrication of Composites

The resin is mixed with the fly ash in selected ratio and mixed with 2% of hardener. First of all the mould is coated by a release anti-adhesive agent, preventing sticking the mould part to the mould surface. Layer of the resin, fly ash mixture and reinforcing fiber fabric are applied. Hand lay-up technique are used for the fabrication and hand roller is use for rolled on the lamina to avoid entrapped air bubbles and void. This process is repeated with four times. The part is applied with a load of 200 N for 2 hours and cured at room temperature for 48 hour. The above steps are repeated for preparation of all samples.

Testing Standards

After fabrication, the specimens are to be tested for tensile strength as per ASTM D638, Compressive strength as per ASTM D695 and flexural strength as per ASTM D790. The all tested are tested by the universal testing machine.

DESIGN OF EXPERIMENT

Design of experiments (DOE) is the method of predicting the experimental result with minimum number of runs for a multivariate complex problem. Design expert is a DOE software which guides in conducting minimum number of experimental run and analysing the result. Design-Expert 10 is used and mixture design option selected as the weight percentage one constituent affects is dependent to other constituent. In the mixture design, number of mixture components is set as only the fly ash and human hair weight percentage are varied and epoxy resin is kept constant percentage. The following experimental matrix of 5 number of run (Table 1) is obtained for the tensile, compressive and flexural strengths as responses. And the tested responses are tabulated (Table 1).

Table 1: Experimental Matrix and the Tested Responses

Run	Epoxy Resin (wt%)	Fly Ash (wt%)	Human Hair (wt%)	Tensile Strength (MPa)	Compressive Strength (MPa)	Flexural Strength (MPa)
1	40	60	0	4.63	38.6	12.747
2	40	55	5	6.79	37.5	12.728
3	40	50	10	9.29	45.2	20.935
4	40	45	15	10.15	50.8	21.282
5	40	40	20	12.38	48.6	24.943

RESULTS AND DISCUSSIONS

The result is obtain Design of Expert software and the result are discuss on the Anova and graph for the tensile, compressive and flexural strength by the The obtained result show that all tensile, compressive and flexural strength properties are maximum at the 40 Wt% of fly ash in fly ash, human hair mixture with epoxy resin.

Table 2: Anova for Tensile strength with Design-Experts

Source	Sum of Squares	Degree of Freedom	Mean Square	F value	P-value Prob>f	
Model	35.57	1	35.57	171.42	<0.0010	Significant
Linear Mixture	35.57	1	35.57	171.42	<0.0010	
Residual	0.62	3	0.21			
Cor Total	36.19	4				

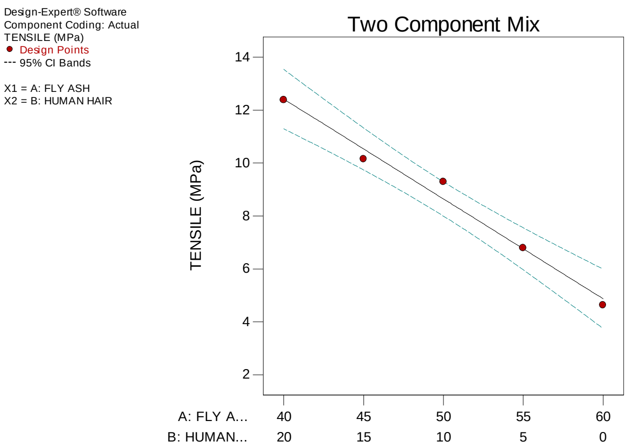

Figure 1: Graph for the Tensile Properties of the Developed

Table 3: Anova for Compressive Strength with Design-Experts

Source	Sum of Squares	Degree of Freedom	Mean square	F value	P-value Prob>f	
Model	110.89	1	110.89	11.37	0.0434	Significant
Linear Mixture	110.89	1	110.89	11.37	0.0434	
Residual	29.26	3	9.75			
Cor Total	140.15	4				

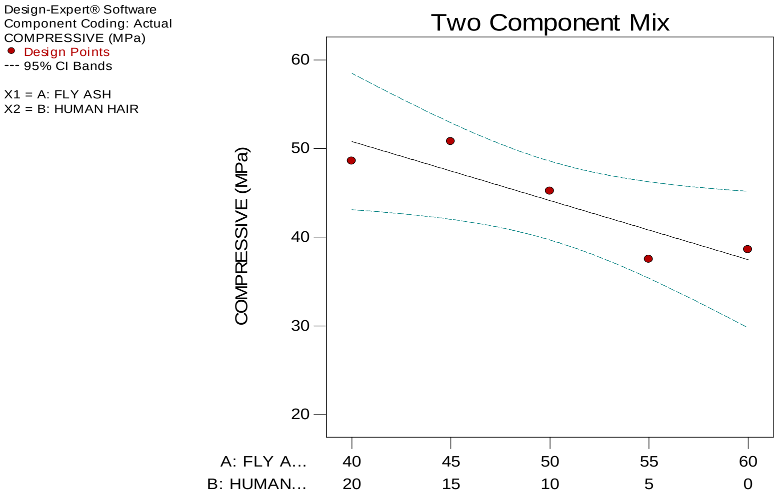

Figure 2: Graph for the Compressive Properties of the Developed

Table 4: Anova for Flexural Strength with Design-Experts

Source	Sum of Squares	Degree of Freedom	Mean square	F value	P-value Prob>f	
Model	108.54	1	108.54	24.96	0.0154	Significant
Linear Mixture	108.54	1	108.54	24.96	0.0154	
Residual	13.05	3	4.35			
Cor Total	121.59	4				

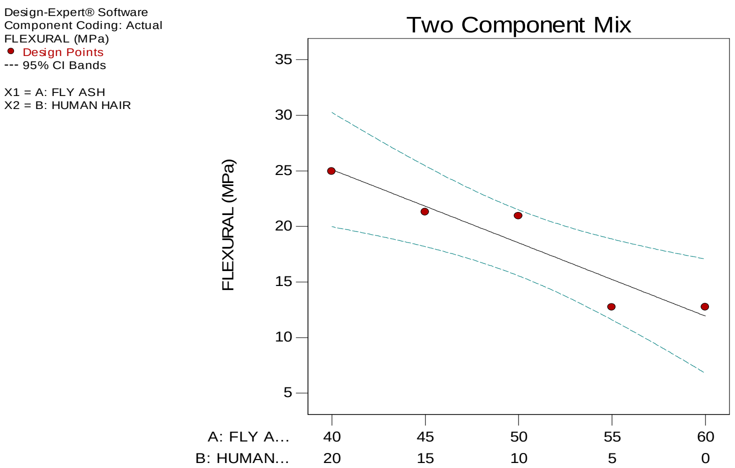

Figure 3: Graph for the Tensile Properties of the Developed

Maximum tensile strength of 12.38 MPa and flexural strength of 24.943MPa is obtained at 40 Wt % fly ash and 20 Wt % of human hair and maximum compressive strength of 50.8 MPa at 45 Wt % fly ash and 15 Wt % of human hair. The graph (figure 1) shows that tensile strength and compressive strength gradually decreases over the entire range while the flexural strength decreases suddenly.

Analysis of Variance (ANOVA) is made for result with the same Design-Expert software. For tensile strength (Table 2) the model F-value of 171.42 implies the model is significant. There is only a 0.10% chance that an F-value this large could occur due to noise. Values of "Prob> F" less than 0.0500 indicate model terms are significant. In this case Linear Mixture Components are significant model terms. For compressive strength (Table 3) The Model F-value of 11.37 implies the model is significant. There is only a 4.34% chance that an F-value this large could occur due to noise. Values of "Prob> F" less than 0.0500 indicate model terms are significant. In this case Linear Mixture Components are significant model terms. For flexural strength (Table 4) The Model F-value of 24.96 implies the model is significant. There is only a 1.54% chance that an F-value this large could occur due to noise. Values of "Prob> F" less than 0.0500 indicate model terms are significant. In this case Linear Mixture Components are significant model terms.

Table 5: Properties of Developed Composites Compared with Wood and Conventional Wood Substitutes

Material	Developed Composites	Medium Density Fiber Board	Teak Wood
Tensile strength (MPa)	4.63 -12.38	0.6 - 0.7	4.0 - 5.0
Compressive strength (MPa)	37.5 - 50.8	10.0 - 15	40.0-49.0
Flexural strength (MPa)	12.72- 24.94	20.0- 35.0	18.0- 20.0

CONCLUSIONS

The tensile, compressive and flexural strength of the developed composites of different weight percentages of fly ash, human hair are significant. With the consideration, based on the application and strength required, the weight percentage of the fly ash in fly ash, human hair could be varied with fixed weight percentage of epoxy resin. And the properties are comparatively high with the properties of teak wood and medium density fiber boards. Thus the developed composites would be a high performing, economical wood substitute.

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